Energy Policy 129 (2019) 511–520

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Current and future struggles to eliminate coal

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ARTICLE INFO

Keywords:
Coal
Climate change
Paris agreement
Mitigation
National policy
Emissions reduction

ABSTRACT

Reductions in coal use necessary to meet the objective of keeping global temperature increase well under 2.0 °C faces serious political economic hurdles. To transition from coal, existing use must be eliminated and new growth in coal consumption must be stymied. Efforts to reduce existing consumption in a speedy manner faces challenges in domestically oriented markets where coal industry coalitions resist anti-coal policy and pursue industry protection. In addition, we identify a serious loophole in coal restraint exercised by a number of the users including: China, Japan and Korea. Continued support for coal capacity expansion abroad in both public and private sectors in these markets appears to reflect the lack of incentives, or sanctions in reining in such external capacity expansion. Such external expansion currently is not counted in nationally determined commitments for the Paris Agreement of the United Nations Framework Convention on Climate Change (Paris Agreement). Without greater national political efforts, the necessary reduction in coal use cannot be achieved.

1. Introduction

In 2015, the world committed to limit global warming to well below 2.0 °C under the Paris Agreement. To have a 66 percent chance of remaining under 1.5 °C of global warming, the current amount of greenhouse gases that can be emitted into the atmosphere will be exhausted by 2021 (McSweeney and Pearce, 2017). To achieve the targets, then, set out in the Paris Agreement, much remains to be done.

One essential requirement to mitigate climate change is, in our view, the phase-out of coal power. The IPCC reported in 2018 that all pathways to limiting global warming to 1.5 °C requires a virtual phase-out of coal from electricity generation by 2050 (Intergovernmental Panel on Climate Change, 2018, 17). However, after three years of decline in global coal consumption, coal consumption increased in 2017 (BP, 2018). The International Energy Agency (IEA) expects coal demand to have grown again in 2018 and remain stable until 2023 (International Energy Agency, 2018, 1). Clearly, the challenge of eliminating coal remains a difficult one.

Fundamentally, there are two components to ensuring the world phases out of coal as an energy source. The first is to ensure that current consumption is drawn down. The second is to ensure that future energy demand is met by cleaner sources of energy. We will separate our discussion between these two processes, focusing on what we find to be the most salient obstacle: the political incentives to preserve coal use in states with a largely domestic market, and the commercial incentives for technologically advanced coal markets to support global coal capacity expansion respectively.

2. Part I: trading regimes and the political struggle to eliminate existing coal consumption

If existing coal consumption is to be reduced to nearly zero for power generation by 2050, the main challenge will be to overcome the political incentives to preserve coal use in domestically-oriented markets. At present, coal use is limited to a select few countries and largely remains a domestically contained phenomenon. While the availability and cost of alternatives play a significant role, the presence of a dominant end-to-end coal industry will incentivize policies that will sustain coal consumption even when it becomes uncompetitive. Given that current goals to limit global warming require a transition out of coal that is faster than the status quo, it is essential to understand and resolve these political obstacles to coal use reduction.

If one looks at coal use, it is largely confined to a number of key national markets. For the past decade, the same top eight consumers accounted for over 80 percent of coal consumption globally, with no other market exceeding 2 percent of total global coal consumption (BP, 2018). As shown in Table 1, China, India, US, Japan, Russia, South Korea (Korea), South Africa and Germany have consistently been the world's largest coal consumers since 2008 (see Table 2).

The global transition away from coal hinges on the ability of these dominant markets to adopt cleaner energy sources. While some markets like Indonesia are experiencing rapid growth in coal consumption, the

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https://doi.org/10.1016/j.enpol.2019.02.031
Received 10 September 2018; Received in revised form 9 February 2019; Accepted 11 February 2019
Available online 23 February 2019
0301-4215/

Table 1
Coal consumption by year – million tonnes of oil equivalent (BP, 2018).

Coal Consumer	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total World	3501	3447	3606	3779	3794	3865	3862	3765	3706	3731
China	1609	1686	1749	1904	1928	1969	1954	1914	1889	1893
India	259	281	290	305	330	353	388	395	406	424
US	536	471	499	471	416	432	431	372	341	332
Japan	120	102	116	110	116	121	119	119	119	121
Russia	101	92	91	94	98	91	88	92	89	92
South Korea	66	69	76	84	81	82	85	85	82	86
South Africa	93	94	93	91	88	88	89	83	85	82
Germany	80	72	77	78	80	83	80	79	76	71
Indonesia	32	33	39	47	53	57	45	51	53	57
Poland	55	52	55	55	51	53	49	49	49	49

Table 2
Coal production ranking by year (BP, 2018).

Top Coal Consumer	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
China	1	1	1	1	1	1	1	1	1	1
US	2	2	2	2	2	2	2	2	2	2
India	4	3	3	3	4	5	5	4	4	4
Russia	5	6	6	6	6	6	6	6	6	6
South Africa	7	7	7	7	7	7	7	7	7	7
Germany	10	10	11	11	11	11	11	11	11	11

challenge of limiting coal growth is of a different nature and will be discussed in Part II of this article.

There is evidence that like households, national economies also move along an energy ladder. Paul Burke reviewed the energy portfolio of 134 countries from 1960 to 2010 and found that as they developed, countries first moved into high-carbon intensity energy sources like coal before moving to cleaner sources like natural gas and renewables as economic development continued (Burke, 2013, 485). His work also identified factor endowments as an influence over the ease of energy transition, finding that countries rich in a particular resource will have a harder time moving into a higher level in the energy ladder (Burke, 2013, 485). This suggests that countries with a large supply of coal would find it politically difficult to lower their consumption.

This poses a challenge to lowering coal consumption considering most of the major consumers of coal are endowed with large coal supplies of their own. With the exception of Japan and Korea, the top eight consumers of coal also rank amongst the top producers of coal.

Indonesia and Australia, which composed 15 percent of world coal production in 2017, also ranked as the ninth and twelfth highest consumers of coal respectively (BP, 2018). With so much of coal consumption taking place in countries with large coal supplies, it is crucial to understand why higher resource endowments make a transition into more advance energy difficult.

In our view, the higher resource endowments effects examined by Burke reflect political challenges associated with energy markets with a domestically oriented trading regime. The markets with large supplies of coal will supply their own consumption, creating an integrated supply chain. This forms a coalition of interested actors that will resist efforts to reduce coal consumption and promote policies that protect coal from competition.

2.1. Policy incentives and trading regimes

The presence of both coal production and domestic consumption within an economy can generate a coalition in defense of the coal industry. While the availability of alternative sources of energy may create a market-driven shift away from coal and environmental social movements may induce policies aimed at limiting coal, the mounting pressure on the industry will generate policy reversals and industry protections. Therefore, a government's propensity to implement pro-coal policy or reverse anti-coal policy increases with two factors: how domestically oriented a market is and how much the coal industry is struggling.

The strength of industry interest is evident in the inability of anti-coal politics to gain traction in countries with significant amounts of coal use. The only countries with a serious commitment to phase out coal are insignificant compared to total coal consumption. Within the “Powering Past Coal Alliance”, the largest coal consumer is Canada, which only accounts for a measly 0.5 percent of global coal consumption. All of its members combined amount to less than 3 percent of total coal consumption (BP, 2018). While Germany has announced its intention to eliminate coal consumption by 2038, a model jointly compiled by Greenpeace and Coalswarm showed that all OECD economies need to phase out of coal by 2030 to meet the larger target of a global phase out of coal by 2050 (Nace, 2018, 3; Reuters, 2019).

The coal industry has strong influence because its interests extend beyond the mere power generation sector. As Richard Vietor points out in his research, coal is tied to many interests in the political and economic settings of a country: finance, railroads, steel, and metals production. Such an array of interests can facilitate powerful political coalitions that can dissuade policymakers from vigorously implementing policies that might lead to the reduction in the use of coal (Vietor, 1980, 20–24). Coal's political power comes from the wide assortment of players involved in the entire process of turning coal in the ground into energy and energy use in the grid, and its strong association with chemical and steel industries.

Additionally, the production of coal is typically concentrated in specific regions and thereby elicit strong localized political support that will be voiced in national policy. Coal mines, like other mines, serve as a concentrated source of employment vital to the economic well-being of their surrounding community. Disruption of such industries lead to unemployment and have the potential to create political dissatisfaction within the local community. Whether one is a local representative seeking election, or a local official trying to keep contained political unrest, incentives exist to keep the coal industry thriving. The concentration of coal deposits within certain geographical regions, as with forestry and fishing, create an institutionalized regional interest in the survival and prosperity of the industry.

Moreover, the more pressure the coal industry is under, the greater the effort to reverse anti-coal policy and to pursue industry protection

in the political space. The coal coalition strengths in adverse market conditions as supporting industries like railroads, steel, and banking care about coal as clients or suppliers integral to their business success (Vietor, 1980, 20–24). However, for these situations, the largest concern is the prospect of bankruptcy, leading to loan defaults, sudden loss of a critical customer, or supply disruptions that can be calamitous to a supporting industry firm. Such risks are not of concern when the industry is enjoying strong commercial success. As such, the more the commercial performance of the industry deteriorates, the greater the incentive for societal actors to band together and resist the industry's decline politically.

Such pressures form the crux of resistance against anti-coal politics. In his case study of coal politics in New South Wales, Geoff Evans identifies that social discourse of climate change policy is dominated by the perception of a tradeoff between jobs and environment (Evans and Phelan, 2016, 331). While Evans sees the potential for environmental justice and just transition discourses to challenge the "jobs vs. environment" hegemony, for now it remains the dominant narrative (Evans and Phelan, 2016, 332). This discursive hegemony means societal actors, such as labor, see environmental policy as a threat to their jobs and that their jobs can be traded at the expense of the environment. This means that with a greater need to preserve their jobs, the more actors benefiting from the coal industry will resist environmental policy.

This framework of policy coalitions and trading regimes focuses primarily on the policy influence of the coal industry, not how fast a country is able to transition out of coal. Factors like the availability and market competitiveness of alternate energy sources with markets have a strong influence on the natural progression of an economy into higher quality energy. Nonetheless, the policy framework is crucial as policy is necessary to speed up the transition out of coal and to ensure it is completely phased out. Even if coal becomes an outdated technology, some level of coal use will still persist in places where it is plentiful. As Igor Bashmakov noted in his discussion of historical energy transitions, even seemingly obsolete energy sources like biomass still retain a role: in 2007 biomass still composed 5 percent of total energy use in Canada long after biomass had been supplemented by modern energy sources (Bashmakov, 2007, 3584). In comparison, coal consumption composes a similar share of Canada's primary energy from commercially traded fuels (BP, 2018). Political resistance will prevent the policies necessary for a speedy and complete energy transition from being implemented and can impede the progress of even market-driven coal use reduction if the coal seeks out industry protections.

When an economy possesses an integrated market of both domestic coal production and consumption, governments not only face pressure from coal miners and corporations, but also the related commercial affiliates and the communities the coal industry supports. As such, the more that the end-to-end supply coal supply chain is contained within one political entity, the stronger the political influence of the coal industry within that entity.

If true, this is problematic considering the largest coal markets also tend to be domestically oriented. As shown in Fig. 1, the largest coal markets, China, the United States, and India all possess strong domestic trading regimes. This suggests that when the coal industry declines within these markets, their governments will begin facing political pressure and rollback policies reducing coal consumption and perhaps even undertake measures to provide support to the industry against an unfriendly marketplace.

To test whether domestically oriented markets do indeed face difficulties when trying to reduce coal consumption, we will examine three major coal markets that have attempted to reduce coal consumption. China and the United States are both highly domestically oriented in their trading regime, and so should experience policy reversals when there is an attempt to reduce coal consumption. In contrast, Germany is less domestically oriented, and so should have less political protection for coal when compared to the United States and China. The remaining major markets have yet to adopt any ambitious policies designed to strongly limit or decrease coal consumption. Climate change commitments for South Africa and India still allow growing coal consumption in the medium term and Japan, Korea, and Russia have yet to initiate any major push to reduce coal consumption.

2.2. China

China possesses one of the most domestically oriented trading regimes of the major coal markets, producing the vast majority of its consumption. As such, we expect efforts to reduce coal use are likely to face resistance as policies designed to shrink the coal industry take effect. Since a combination of market dynamics and political efforts to limit coal use led to the peaking of coal consumption in 2014, China has indeed experienced some policy reversals and took steps to limit the coal industry's decline.

In China - 'Coal is King'. From 2005 to 2012, 15 to 18 percent of China's GDP came from the coal industry and industries that use coal as a primary fuel or raw material (Xie et al., 2014). China was not perceived to be particularly ambitious in climate policy during this time. Moreover, as revealed by revisions of China's energy statistics, even the progress made on limiting greenhouse gas emissions growth had been overstated (Li et al., 2018, 34). A model completed in 2013 showed that based on existing supplies and policy patterns, coal use was only likely to level off and peak by 2024 (Wang et al., 2013, 212).

However, policy driven by concerns over air pollution and availability of alternatives pushed coal consumption down in recent years. Beginning with the Renewable Energy Law in 2005, China has taken an aggressive approach to growing its renewable energy, experiencing exponential growth in wind and solar, attaining the position of the world's largest consumer of renewable energy by 2016 (BP, 2018; Wang et al., 2010, 1872). Energy production through hydroelectricity and nuclear also outpaced energy demand changes since 2007 (BP, 2018). Furthermore, nationwide air pollution issues in 2013 led to increased public policy attention on limiting air pollution from the Chinese government (Schwabe and Hassler, 2016, 59). After the onset of the air pollution crisis, China's coal consumption fell in 2014 for the first time since 1981 (BP, 2018). That year the government also took on a number of major commitment: the State Council criticized existing policy for lacking ambition and undertook major steps to lower fossil fuel use in the 2014–2015 Action Plan on Energy Saving, Emission Reduction, and Low Carbon (State Council, 2014). Despite continued rising energy demand, China managed to reduce its coal consumption in 2015 and 2016 as well.

The difference in policy ambition in China is most apparent when comparing the Thirteenth Five Year Plan released in 2016 to the Twelfth Five Year Plan released in 2011.

As shown in Table 3, in the Twelfth Five Year Plan, coal is mentioned almost entirely in the context of how to expand its production and to facilitate its development as an industry, with discussion of both expanding the coal industry and supply infrastructure such as railways and ports (National People's Congress, 2011, 9, 11–15). In comparison, the discussion of building a modern energy system in the Thirteenth Five Year Plan opens with a discussion with restricting and limiting coal development (National People's Congress, 2016, 84). The plan also called for the consolidation of coal power generation to reduce overcapacity, and the replacement of small and medium sized coal power generation plants with alternative clean energy or natural gas (National People's Congress, 2016, 62, 84, 126, 128, 131). The ambition of the 13th Five Year Plan on coal use reduction is a vast improvement on the 12th Five Year Plan. Unfortunately, the ambitious policy direction on coal set out in the Thirteenth Five Year Plan met resistance and did not result in the continued decline of coal consumption.

As China possesses a domestically oriented coal market, one would expect policy reversals and industrial protections for coal as China experienced a decline in its coal consumption and faced resistance from

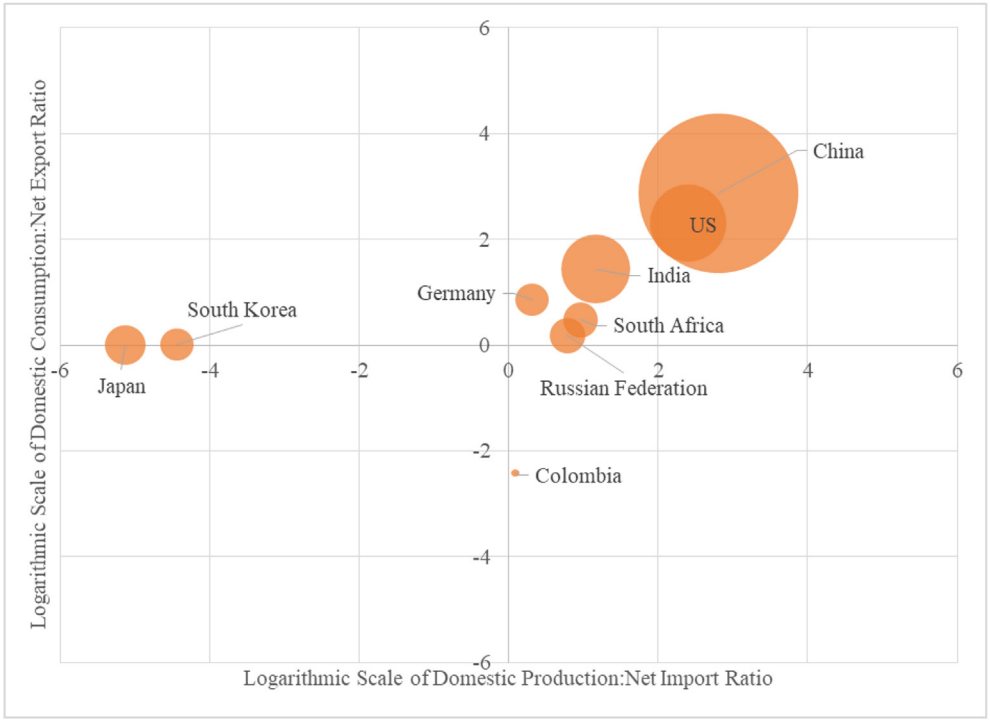

Fig. 1. Trading regimes of top coal consumers 2008–2017**. *Size of circle represents average annual total coal consumption, chiefly import dependent markets will be placed on left atop the x-axis while chiefly export dependent markets will be placed on bottom atop the y-axis, the more domestically contained a market, the closer it approaches the upper-right hand corner. **Colombia is added for comparison as an example of a chiefly export oriented coal market.

coal interests. Indeed, this is indeed what has unfolded since coal production began to decline and anti-coal policies came into force. In the mining sector, there was a sharp rise in protests and strikes during the latter half of 2015, peaking at 37 mass incidents nationwide during the month of January 2016 (China Labour Bulletin, 2017). This unrest was emblematic of the societal cost cutting coal consumption would impose, and was a harbinger for the policy roadblocks to come. China instituted a production quota in April 2016, but the economic stress it placed on the coal industry led to a repeal of the policy only seven months later (Sultoon and Sharma, 2017; Schaeffer, 2017). Construction of coal plants continued even as utilization rates of coal power generation plants sit at record lows. According to the report from the U.S. Center for American Progress, Chinese coal power generation plants are all running at about the same utilization rate of 47.7 percent of total capacity (Hart et al., 2017). The major players in coal power generation are state-owned in China, so at least for the sake of public financial health it would be prudent to consolidate this capacity and limit new installation of coal power generation. Rather than doing this, China is instead keeping these plants open and building even more capacity despite it being an uneconomical use of state-owned assets effectively subsidizing the coal industry. As of July 2017, CoalSwarm, a research network dedicated to developing information resources on coal, tracks nearly 153GW of coal power generation capacity that have either been announced, in pre-permit stage, or permitted, and over 147GW currently under construction (EndCoal, 2017). Local governments have supported this additional coal capacity development in an effort to maintain jobs and tax revenue within their districts (Hart et al., 2017). By 2017, coal consumption had begun to increase once more (BP, 2018). The interests of labor and coal communities limited the ability of China to hasten its transition away from coal.

2.3. United States

Similar to China, the United States possesses a largely domestic trading regime. We would expect the United States to experience policy reversals as the coal industry declines. In recent years, the United States has experienced a rapid decline in coal consumption. In part due to environmental policy, but also due to competition from energy sources particularly shale gas. The pressure on the coal industry has led to reversal of anti-coal policy and even some preferential treatment for coal power generation. Although a more favorable policy environment may not result in a revitalization of coal use in the United States, it certainly will slow the transition out of coal than if the policies restricting coal use remained in place.

Table 3
Coal Policy 12th vs 13th FYP of the People's Republic of China.

12th Five Year Plan	13th Five Year Plan
1. Develop safe and clean coal mines, cleaner and more efficient coal power generation, invest in R&D for technologies like coal-gasification. (National People's Congress, 2011, 11)	1. Address coal overcapacity through mergers, debt restructure, bankruptcy liquidation, etc. (National People's Congress, 2016, 62)
2. Expand the coal industry in Shaanxi, Shandong, Inner Mongolia and Ningxia, Shanxi, Yunnan and Guizhou, Xinjiang and other areas (National People's Congress, 2011, 12)	2. Invest in innovations projects and develop clean and efficient coal use such as ultra-supercritical power generation. (National People's Congress, 2016, 25, 88)
3. Improve interregional transport networks for coal (National People's Congress, 2011, 13–15)	3. Restrict and limit coal development, make coal exploitation more eco-friendly and explore new technologies in coal power generation (National People's Congress, 2016, 84)
	4. Improve coal supply and transmission infrastructure (National People's Congress, 2016, 85, 87)
	5. Replace small to medium coal power generation plants/boilers with alternative energy and gas (National People's Congress, 2016, 126, 128, 131)

Coal consumption and production declined by a substantial amount over the past decade. Both consumption and production were over 500 million tons of oil equivalent (MTOE) in 2007, but have declined to within the 300s by 2017 (BP, 2018). Much of this decline of around 200 MTOE in coal consumption was offset by over 200 MTOE of growth in consumption of natural gas and renewables (BP, 2018). If one compares the productivity of the best performing shale gas wells from 2004 to 2015, the difference is nearly five-fold (Middleton et al., 2017, 91). While this transformation has displaced a substantial amount of coal use, there were also policies implemented during this time that hampered coal's competitiveness and helped to accelerate the transition away from coal.

During the course of the Obama Administration, a number of new environmental regulations put additional pressure on the coal industry. While several other measures impacted the coal industry, the US coal market Dow Jones decline rapidly after the announcement of the highly stringent Mercury Air Toxic Standards in 2011 (Sussams and Grant, 2015, 8–9). Much of the massive decrease in coal generation capacity in 2015 came as a response to the implementation of Mercury Air Toxic Standards (Dimsdale et al., 2015b, 14). Other policies, like more stringent EPA air quality standards, the Cross-State Air Pollution Rule, the Cooling Water Intake Structures Rule, and the Coal Combustion Residuals Rule also have raised the cost of generating electricity from coal (Sussams and Grant, 2015, 26–27).

The declining competitiveness of coal was keenly felt in the industry. The impact of the post-financial crisis decline in natural gas prices is clear. Coal's prominence in the electricity generation space has shrunk and almost 50,000 jobs were shed in the coal industry from 2008 to 2012 (Haerer and Pratson, 2015, 96). Continued pressure exerted by environmental policy resulted in political resistance and policy reversals.

As the coal industry declined, its influence in government increased. Coal mining contributions to congressional candidates and parties increased from $1.3 million in 1996 to over $US13 million in 2016 (Center for Responsive Politics, 2017). Moreover, candidate Trump managed to secure his electoral victory in part by winning at least two crucial swing states - Ohio and Pennsylvania. A part of Trump's appeal to voters in these important states, in addition to Kentucky, West Virginia and the West, lay, it would appear, in his repeated electoral efforts to oppose coal's elimination and in particular his oft repeated promise to “end the war on coal” (Presidential Transition Team of Donald Trump, 2016).

Although coal consumption declined, political resistance meant anti-coal policies were being reversed. When the Obama Administration enacted the Clean Power Plan (CPP) in 2015, twenty-seven States, along with various companies and business groups, requested to have the plan blocked in the courts (Hurley and Volcovici, 2016). Their efforts succeeded with the United States Supreme Court reaching a 5-4 decision to halt the implementation of the policy (Hurley and Volcovici, 2016). After the election of Trump, the United States lifted restrictions on coal-leasing, which would allow for the development of coal production on federal lands (Devaney and Wheeler, 2017). In 2017, 2018, in fact, coal production and employment in the coal industry both rose compared to their low point in 2016 (United States Energy Information Administration, 2017; Duquiatan and Kuykendall, 2018).

In 2018, the EPA proposed the Affordable Clean Energy (ACE) Rule. It removed the aggregate emissions limitations of the CPP and recommends a target based on carbon-intensity at the plant level as well as leaving states to form their own emissions reductions plants in accordance with this new intensity-based guideline (United States Environmental Protection Agency, 2018, 9–10). Since there is no total emissions cap, these changes open the prospect of increasing the size of America's coal fleet so long as people are willing to make the investment and new projects meet state efficiency standards. Moreover, the EPA proposed the removal of New Source Reviews on projects to improve the heat rate of existing power plants (United States Environmental Protection Agency, 2018, 10–11, 47, 79). Considering the old age of most America's coal plants, this could dramatically extend the lifetime of the current coal-fired industry in the U.S. Under the Obama Administration rules, the required regulatory upgrades would eventually have forced these plants to shut down (United States Energy Information Administration, 2016). So, while ACE has the short-term benefit of incentivizing some improved power plant efficiency, it also allows an extension of life on many of America's existing coal-fired plants. These older plants will raise emissions in the long-run.

While there is little likelihood of a coal renaissance in the United States, these policy reversals and loosening of regulations will slow down the speed by which America transitions out of coal. With the limited time and carbon budget remaining for limiting warming to less than 2.0°, these political challenges need to be overcome.

2.4. Germany

Germany is an interesting case to examine because it transitioned from a largely domestically oriented coal market to a more import oriented one in the past decade. As such one should expect examples of policy reversals in earlier attempts in Germany to reduce coal consumption, but as Germany becomes more import oriented, the ability of the coal industry to seek out political protection should decline.

In the 1990s, Germany underwent a similar energy transformation as the United States today, cheap natural gas replaced coal and coal consumption underwent a rapid decline. After German reunification in 1990 and the conclusion of the Cold War, the integration of the East and West German markets and more readily available access to Russian resources led to a rise in use of natural gas, which also composed most of newly constructed power generation capacity after liberalization of the electricity market in 1998 until 2008 (Pahle, 2010, 3432). From German reunification in 1990–2008, coal consumption declined by 60 MTOE, a 40 percent reduction (BP, 2018). Coal production declined even more, by 70 MTOE, during the same period (BP, 2018).

The decline of the coal industry during this time yielded to pressures on the social fabric of Germany and coal power generation managed to thrive through the pursuit of preferential policies. In 1992, there were more jobs in German lignite and hard coal mining than there were for the entire conventional energy sector in 2013 (Hockenos, 2015). With around half the industry disappearing, this undoubtedly created political pressure to ease the stress on coal interests driven by Germany's energy transition.

The coal industry did achieve policy victories that turned around the economics in favour of more coal over gas. Coal power had less stringent requirements than natural gas under the European Union Emissions Trading Scheme during phase I and II from 2005 to 2012 (Pahle, 2010, 3435). Investment in coal was also made in hopes of improving Carbon Capture and Storage (CCS) technology, as well as improved efficiency of coal power (Pahle, 2010, 3437–3439). As a result, most power generation capacity development laid in coal rather than gas after 2008 (Pahle, 2010, 3433). Despite the environmental advantages of natural gas, Germany created a policy environment that gave coal an artificial advantage in the power sector.

However, while coal consumption did not change much year on year, coal production continued to decline as Germany substituted its own production in favour of imports from Poland. This resulted in Germany sliding more into being an importer rather than a domestically concentrated market. If the trading regime framework is correct, then Germany should have less political resistance to anti-coal policies. So far, coal consumption has declined steadily since 2013 and Germany has pledged to phase out of coal use by 2038 (BP, 2018; Reuters, 2019). While still insufficient to meet the goals of the Paris Agreement, which under the IPCC report's coal phase-out schedule meant OECD states would need to phase out of coal by 2030, it is at least a start (Nace, 2018).

2.5. The political economy challenge of coal

The decline in commercial viability of coal will not be enough to put coal use out of business. When the availability of cheap Middle Eastern oil flooded the global market in the 1950s, the United States and the United Kingdom instituted various protectionist measures to ensure the survival of the uncompetitive coal and domestic petroleum industries (Chick, 2007, 9–10). The political questions of social welfare for communities and commercial interests dependent on coal ensured its survival.

Today, among the major markets that both produce and consume coal in significant quantities, those same political interests present a strong challenge to efforts to reduce coal use. Both the United States and China implemented strategies designed to 'ramp down' coal production that later were reversed due to political forces. Even when coal cannot survive on its own, political interests may use policy to ensure that coal power generation remains viable even in hostile market conditions as China does keeping under-utilized capacity open and Germany did through preferential treatment within its emissions trading scheme.

While efforts to reverse policy or seek preferential treatment might not succeed in revitalizing the coal industry when other energy sources are far more competitive like in the U.S., it can keep coal around for longer. The German experience with their own gas boom demonstrates that coal reduction can plateau as well, so the United States would need to be careful not to rest on its technological laurels. Policy remains an important lever in the energy transition and its associated political challenges must be overcome if the world is to transition out of coal at the necessary speed. Ultimately, policy must accommodate for the social repercussions of a diminishing coal industry and ensure that it is politically sustainable while also enabling a faster reduction in the use of coal.

3. Part II: the untimely expansion of coal capacity

Current major markets may hold most of the world's coal generation capacity, but the future growth of coal lies elsewhere. While the top eight markets discussed in Part I compose the bulk of global coal consumption, the fastest rate of significant coal consumption growth are happening in markets like: Indonesia, Turkey, Vietnam, and Malaysia. For these countries annual coal consumption has grown between 50 percent to over 100 percent within the past decade (BP, 2018).

One key challenge to successfully transitioning away from coal is to limit the amount of coal used in these markets so they do not become locked-in like the China, the U.S. or Germany, where attempts to reduce coal use are met with policy reversals and protectionism. A commonly proposed solution to this is to leapfrog energy technology in developing markets so that they transition immediately into renewables. Burke cited this as the solution to the dilemma presented by the presence of national energy ladders as numerous nations embark on their industrialization journeys (Burke, 2013, 485). The problem, however, is rather than discouraging countries to adopt coal power, a large amount of investment, financing, and development assistance has been made available for the expansion of coal capacity in developing markets.

While there may be a recipient preference for investment and financing for coal power generation, there is still nonetheless a dearth of resources made available by the investment and finance suppliers. Limiting the willingness of countries to support coal capacity expansion outside their own borders is an important matter that can help limit the growth of coal capacity globally.

Despite strong commitments to reduce greenhouse gas emissions by China, Japan, and many other developed states, there has been a tremendous amount of support for coal capacity expansion in recent years. While governments claim that they support the transition to cleaner energies, public financing in 2016 by the G20 countries contributed $USD10 billion to coal power but only $USD4 billion to renewables in comparison (Chen, 2017). Private sector financial institutions such as Morgan Stanley and Wells Fargo have also committed to reducing lending to coal development projects, but the availability of finance for coal remains strong (Nussbaum, 2017). From January 2014 to September 2017, international banks have channeled $630 billion to the 120 top companies planning to construct new power plants (Marriage, 2017).

The mismatch between expressed commitments to lower domestic coal use and the continued support for coal capacity expansion abroad in both public and private sectors may reflect the lack of incentives in reining in such external capacity expansion. The Paris Agreement's nationally determined contributions (NDCs) framework creates voluntary targets for what individual countries choose to do to limit emissions within their own borders. These NDCs, however, do not involve restrictions on a country's action outside of its own borders. For instance, China does make a commitment to improving South-South Cooperation on climate change but does not commit China to restricting its development assistance to projects with green energy and cleaner fossil fuel technology (United Nations, 2015). Supporting coal projects abroad provides business opportunities for domestic utility companies as well as supporting industries providing professional services, construction, and materials. However, as shown in Table 4, the bulk of public coal power plant financing in recent years appears to come from a few select major players.

China, Japan, and Korea, what we refer to in this article as the 'Big Three', assume the lead by far. But in addition, Indian and German public financing for coal expansion abroad since 2013 also exceed $1 billion each. While China holds the lead in both, it is interesting to note that the next largest contributors of public financing for coal abroad - Japan, Korea, are not the next largest consumers of coal at home (India, United States). This suggests that different dynamics may be at play for the external expansion of coal capacity than those for domestic coal capacity.

3.1. China

Along with being the largest domestic market for coal, China is responsible for a substantial amount of international coal financing and capacity expansion. Data collected by Urgewald, a German environmental NGO, shows that the top 14 Chinese companies have plans to build over 310 GW of coal power capacity abroad (Urgewald, 2017). There are plans to build coal capacity in all the following countries: Pakistan, Malawi, Vietnam, Indonesia, Bangladesh, Cambodia, Georgia, Egypt, the United Arab Emirates, Jamaica, Tanzania, Zimbabwe,

Table 4
Existing and pending public financing for coal power projects since 2013 (Chen, 2017).

G20 Country	Coal Power Plant Financing (USD)
Argentina	$ 199,784
Brazil	$ 753,544
Canada	$ 7,613,200
China	$ 36,911,800,934
France	$ 7,489,014
Germany	$ 1,533,490,841
India	$ 1,687,516,099
Italy	$ 636,846,068
Japan	$ 15,465,724,814
Multilateral	$ 2,208,325,000
Russia	$ 20,000,000
Saudi Arabia	$ 404,631
South Africa	$ 159,898,219
South Korea	$ 5,320,880,334
Turkey	$ 69,066,371
United Kingdom	$ 27,890,055
United States	$ 13,072,636
Total	**$US 64,070,971,545**

Table 5
China's role in expanding coal capacity.

Country	Coal Expansion Plans by Chinese Companies as of 2017 (Urgewald, 2017)	Coal Expansion Plans financed by China as of 2015 (Hervé-Mignucci and Wang, 2015, 18–32)
Pakistan	Yes	Yes
Malawi	Yes	Yes
Vietnam	Yes	Yes
Indonesia	Yes	Yes
Bangladesh	Yes	Yes
Cambodia	Yes	Yes
Georgia	Yes	No
Egypt	Yes	No
United Arab Emirates	Yes	No
Jamaica	Yes	No
Tanzania	Yes	Yes
Zimbabwe	Yes	Yes
Morocco	Yes	Yes
Mongolia	Yes	Yes
Iran	Yes	Yes
Turkey	Yes	Yes
Mozambique	Yes	No
Russia	Yes	Yes
Botswana	No	Yes
Ghana	No	Yes
Nigeria	No	Yes
Zambia	No	Yes
Kazakhstan	No	Yes
Kyrgyzstan	No	Yes
Tajikistan	No	Yes
Uzbekistan	No	Yes
Bosnia and Herzegovina	No	Yes
Montenegro	No	Yes
Romania	No	Yes
Serbia	No	Yes
India	No	Yes
Sri Lanka	No	Yes
Brazil	No	Yes
Myanmar	No	Yes
Philippines	No	Yes

*Some countries listed without planned coal capacity by Chinese companies may have completed the projects already. Some countries listed without coal financing as of 2015 may have acquired financing afterwards from China.

Morocco, Mongolia, Iran, Turkey, Mozambique, and Russia.

Given the size of China's coal industry, and the economic difficulties it faces within the domestic coal market, it is hardly surprising that Chinese companies are exploring business opportunities abroad. While the Chinese domestic market is saturated with supply, many of the countries it is building capacity within have growing energy needs but poor existing energy infrastructure. In such markets, Chinese firms would presumably have a much better chance of turning a profit.

In addition to building coal capacity, China also provides financing for coal capacity expansion. Researchers estimate that $US 21–38 billion worth of Chinese finance in total went to overseas coal power projects from 2005 to 2015 (Hervé-Mignucci and Wang, 2015, 18–32). Aside from supporting projects operated by its own power generation companies, Table 5 shows that Chinese finance is also going to projects in foreign countries that will not be operated by Chinese companies. This financing is incentivized by the competitiveness of Chinese engineering, procurement, and construction firms. Due to their lower costs, Chinese firms are more likely to be successful in bidding for coal projects (Hervé-Mignucci and Wang, 2015, 12). This means that pressures on such firms in the domestic market, whether from oversupply or environmental policy reducing demand, can be partly side-stepped by satisfying demand in international markets.

Emerging markets have rising energy demands and coal may indeed be necessary in the short term to fulfill this increasing need for energy. However, a responsible approach to financing such project means at least using the cleanest, most efficient technology to minimize the harm the new enlarged capacity will create. China's record, however, on this matter is rather mixed. New coal generation capacity in China often uses supercritical or ultra-supercritical technology, generating power at temperatures and pressures where there is no difference between water gas and liquid water. These technologies, therefore, maximize efficiency in the burning of coal. Some of its projects abroad employ such technology. The Hubco Power Station in Pakistan currently under construction by a Chinese power generation firm uses such supercritical technology (Source Watch, 2017a). The Hamarawein power station announced in Egypt, sponsored by Shanghai Electric Group, will also use ultra-supercritical technology (Source Watch, 2017b). However, an ongoing project in Sihanoukville, Cambodia, operated by a Cambodian-based Chinese subsidiary, does not employ such technology (Source Watch, 2017c). Despite the high technological capacity of the Chinese coal industry, Chinese projects abroad do not always use the most advanced technology.

3.2. Japan

Japan possesses an importer trading regime. While coal mining used to be an important industry in Japan, coal production underwent a turbulent decline during the 1960s and has continued to decline in subsequent years. As a result, Japan imports most of its coal (Culter, 1999, 17, 48, 52). Hence, Japan has no imperative to sustain domestic coal consumption to support a domestic mining industry. However, Japan does possess a coal power generation industry that can benefit from expansion of coal capacity outside of Japan.

Japanese companies have plans to build coal-fired power generation capacity in several emerging economies. In addition to power plant projects in the domestic market, Japanese companies will build, or expand, coal power generation capacity in: Botswana, Egypt, Indonesia, Malaysia, Mongolia, Myanmar, Philippines, South Africa and Vietnam. In total, projects involving Japanese companies will add 34 GW of coal generation globally (Urgewald, 2017).

Japan is also financing coal capacity expansion. From 2007 to 2015, Japanese export credit agencies and other public financiers provided over $US11 billion to either new coal power plants or power plant expansions - an amount greater than all other members of the G7 combined (Chen, 2016). In addition, there were plans to commit over $US10 billion to financing additional coal projects as of 2015 (Chen, 2016). Japan states that its financing goes toward coal projects that make use of advanced, highly efficient Japanese technology (Win, 2017). This means that even if a non-Japanese company is operating the power plant, high-tech components such as the boilers would need to be imported from Japan, putting money back into the coffers of the broader Japanese coal industry. It should be noted, however, that while Japan promotes the use of high-efficiency coal technology, presumably justifying the Japanese financing of coal expansion as climate finance, there are Japanese projects, such as the Morupule B power station in Botswana that will still be using less efficient sub-critical boilers to generate electricity (Source Watch, 2017d).

Though Japan had planned to expand energy self-sufficiency and move away from fossil fuels, in 2010, the Fukushima nuclear disaster led Japan to shift back toward fossil fuel use, including coal (Koyama, 2013, 279). Prior to this, coal power had experienced a degree of underutilization, which meant that the rise in demand did not lead to a dramatic expansion of coal capacity right after Fukushima (Kuramochi, 2015). Nonetheless, coal power generation remains a growth sector in Japan and the government appears to be committed to the continued expansion of high-efficiency coal power generation to satisfy energy needs (Kuramochi, 2015). This commitment demonstrates that the behavior of financing external projects is not necessarily related to internal market pressures. If a state has a natural advantage in coal power, it may be incentivized to advocate projects that will bring business to its coal firms at home. However, the absence of domestic

market stress might also mean that a state will be more amenable to restrict its financing activities. Japan, for instance, has already concluded a multilateral agreement with other OECD countries to restrict its coal financing to only ultra-supercritical power plants, which took effect in 2017 (Associated Press, 2015).

3.3. Korea

Korea, like Japan, possesses an importer trading regime. Coal is Korea's only fossil fuel energy resource, but even the historic high production volume of nearly 25 million tons would not be able to satisfy Korea's current demand (Global Methane Initiative, 2017). But like Japan, Korea is an active player in the global expansion of coal capacity.

Korean companies are building a sizeable amount of coal capacity both at home and abroad. As of July 2017, Korea plans to build about 23 GW of coal power generation capacity within its domestic market as well as building abroad in: Botswana, Myanmar, Vietnam, Indonesia, Philippines, Swaziland, South Africa, and Mongolia (Urgewald, 2017). In terms of financing, Korea is one of the world's biggest contributors. In total, from 2007 to 2014, Korea provided $US7.09 billion to coal projects through its export credit agencies (World Wildlife Fund, 2015). This is greater than the combined contribution of Germany and the United States to coal financing for power generation (Chen, 2016). However, data on recipients of Korean financing is not as readily available as China or Japan, making it difficult to disaggregate the various destinations of Korean finance.

Korea is a leader in high efficiency coal generation coal-fired plants. Like Japan, 70 percent of its coal generation capacity uses supercritical or ultra-supercritical plants (Callick, 2017). However, some external Korean projects, such as the Morupule B Power Station, a Korean firm that is jointly running the project with Japan, or the Vung Ang power station in Vietnam, use subcritical boilers (Source Watch, 2017d,e). In terms of political incentives and market pressures, Korean firms face a competitive environment with Japanese firms. While recent government changes have led to a more environmentally friendly approach in Korean energy policy, the government seemingly does not intend to put too much pressure on Korean coal (Chung, 2017). Korea is also party to the same OECD agreement on restricting coal finance as Japan (Organization for Economic Co-operation and Development, 2015).

3.4. A high-tech expansion

Coal capacity expansion, whether through a state's companies or its public financing, does not appear to be linked with domestic market pressures. China, which does suffer from a struggling domestic coal power generation market, is a major contributor to coal capacity expansion in other countries, but so are Japan and Korea, where both policy and market conditions remain favorable to coal. Nor does it appear to be linked to market size: while China dominates as the largest coal market in the world, the runner ups, India and the United States play smaller roles than either Japan or Korea in promoting coal expansion outside their borders.

The leading role played by China, Japan and Korea, the Big Three, suggests market competitiveness plays the largest role in determining the behavior of coal capacity expansion in foreign markets. All three countries possess cutting-edge technology in coal power generation. With their ability to build more efficient power plants at cost, these countries have a greater incentive to support coal power expansion abroad, which in turn will lead to more business for their competitive coal companies. In comparison, the power plants of lesser contributors such as Germany and the United States are much older. In fact, for these two countries their coal-fired fleets are 30 and 38 years respectively in comparison to average age of 24 years, for example, in Japan (Dimsdale et al., 2015a, 9; Schulz and Schwartzkopff, 2015, 18; United States Energy Information Administration, 2016). This competitiveness of Chinese, Japanese, and Korean coal technology incentivizes them to fuel capacity expansion abroad.

Japan and Korea's status as the largest contributors of investment and financing in external coal capacity expansion also suggests that this technological incentive is a highly substantive influence leading to the growth of coal consumption in emerging markets. If it were not an important factor on why countries are being given resources to expand coal power generation, then there is no real reason why Japan and Korea rank higher than the United States, which is both a larger economy and a bigger coal user. If technological incentives were not a major influence, then the United States and Germany would rank higher on the list of coal financing providers than their current position.

The advancement of coal technology allows for emerging economies to develop cleaner energy solutions if coal remains a means to meet their energy needs. However, the technology standards in the global market lag behind the leading markets. Of all projects with known technology, 63 percent of China's upcoming coal capacity (planned but not yet constructed) will use ultra-supercritical technology, but, despite China's status as the world's largest supporter of coal energy development abroad, only 24 percent of the rest of the world's planned capacity will use such technology (EndCoal, 2018). While China benefits greatly from the increased efficiency and lower emissions rate of supercritical and ultra-supercritical technology, many of its projects in other countries do not carry such high technological standards. Thus, there is a gap between the standards being applied domestically and for projects abroad.

4. Concluding discussion

The global energy transition faces two major hurdles if it is to move away from coal. The first is the political economy constraints slowing established coal users' attempts to move away from coal-based power generation. The second is the market incentives prompting countries with competitive coal power industries to invest and support the expansion of coal use in new markets.

With domestic coal use, the type of coal trading regime will materially affect the type of political and economic incentives and policies for dealing with environmental pressures to limit coal use. In our analysis, we found that China, the United States, and Germany all saw either policy reversals and/or measures to help coal be more competitive in the market.

We anticipate that reducing or eliminating coal use will be far more difficult than current trends and pronouncements. As markets begin their journey to reduce coal use, if they find themselves to possess domestically oriented trading regimes, they should expect political resistance that causes policy reversals and demand for measures that would slow market-driven phase-outs of coal as well. This has implications for energy transition modelling, as it complicates the matter of future consumption patterns if the policy environment becomes more favorable to coal use as its consumption begins to decline.

It is much more likely that the interests of coal related communities and commercial entities will need to be addressed with some sort of compromise in coal reduction policy. The disappearance of coal mines might be less contested if strong investment flows into the afflicted communities. In some instances, German policymakers have managed to eliminate coal capacity through compensating the coal industry. In 2015, a levy on carbon emissions from the oldest and most polluting power plants had been scrapped due to opposition from industry (Reuters, 2015). In response, the German government offered compensation to utility companies to mothball 2.7 GW of lignite power generation capacity (Reuters, 2015). The compensation costs 1.6 billion euros, but it will also achieve the elimination of 13 percent of Germany's lignite power generation capacity (Steinmeier, 2016, 2, 4). Such policies may be expensive, but they present a solution to the political challenge coal interests would otherwise present to efforts to reduce coal use. While lacklustre in ambition, the new German plan to phase

out coal use by 2038 provides a good starting point on how to accommodate the coal industry to ensure the political sustainability of policies aimed at eliminating coal. While a discourse of Just Transitions already exists, it is important to focus it at the practical necessity of obtaining the buy-in of coal industry stakeholders. If workers and companies do not feel the costs of eliminating coal, then they would be much less inclined to seek out protections or overturn policies to protect coal consumption.

For the expansion of coal capacity in new markets, the incentive is the opposite. While domestic coal use reduction is hardest when the market is in decline, foreign financing and investment has been driven by the technological and competitive strength of the coal power generation industry within the "Big Three".

The question of how to do that deserves further investigation. Quality control and ensuring proper use of resources has been a long standing issue in development assistance and financing, with little demonstrable cases of successful governance regimes. Further scholarship should examine the wealth of literature on delivering quality development financing and foreign direct investment to generate insights on how an agreement could be maintained to eliminate the financing and investment in coal power generation projects abroad. Perhaps a sector specific arrangement like the engine standards maintained by the International Civil Aviation Organization could work for power generation. Given that the largest financiers of coal power also possess the most advanced technology, such an arrangement would not disrupt the status quo or affect their market share.

To ensure a successful energy transition and prevent excess carbon dioxide production, steps must be taken to both reduce coal use effectively in established coal markets and limit the development of new capacity in possible new coal markets. Coal has shown itself to possess strong staying power. Success in reducing its use requires paying close attention to the key drivers of current roadblocks in coal use reduction, addressing both the socioeconomic disruption generated by the move away from coal and the tempting commercial opportunities presented by growing energy demand in emerging markets.

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